

What is claimed is:

1. A dihydroxyalkylaminoalkyl- or dihydroxyalkylaminobenzyl- conjugated solid support, wherein the dihydroxyalkylamino moiety comprises the formula $\text{HO}(\text{CH}_2)_2\text{N}(\text{CH}_2)_2\text{OH}$.
2. The solid support of claim 1, wherein the dihydroxyalkylaminoalkyl group or dihydroxyalkylaminobenzyl group is a diethanolaminoethyl, a diethanolaminopropyl, a diethanolaminobutyl group or a diethanolaminobenzyl group.
3. The solid support of claim 1, wherein the solid support comprises a polystyrene.
4. The solid support of claim 3, wherein the polystyrene is a cross-linked poly(styrene-divinylbenzene) (PS-DVB) copolymer.
5. The solid support of claim 4, wherein the cross-linked poly(styrene-divinylbenzene) (PS-DVB) copolymer is 1% to 2% cross-linked.
6. The solid support of claim 1, wherein the solid support comprises a plastic or a plastic co-polymer.
7. The solid support of claim 1, wherein the solid support comprises a polyphenol, a polyvinyl, a polypropylene, a polyester, a polyethylene, a polyethylene glycol, a polystyrene-copolymer, or a co-polymeric mixture thereof.
8. The solid support of claim 1, wherein the solid support comprises a polystyrene-polyethylene glycol copolymer.

9. The solid support of claim 1, wherein the solid support comprises a poly(vinyl alcohol) (PVA) hydrogel.

10. The solid support of claim 1, wherein the solid support comprises a polyacrylamide.

11. The solid support of claim 10, wherein the polyacrylamide comprises a polymethacrylamide, a methyl methacrylate, a glycidyl methacrylate, a dialkylaminoalkyl-(meth)acrylate, or an *N,N*-dialkyl-aminoalkyl(meth)acrylate.

12. The solid support of claim 1, wherein the solid support comprises a cellulose or cellulose acetate.

13. The method of claim 1, wherein the solid support of step (a) comprises an inorganic composition selected from the group consisting of sand, silica, silica gel, glass, glass fibers, gold, alumina, zirconia, titania, and nickel oxide and combinations thereof and equivalents thereof.

14. The method of claim 1, wherein the diethanolaminoalkyl- or diethanolaminobenzyl-conjugated group is covalently bonded to the solid support through a spacer group.

15. The method of claim 14, wherein the solid support comprises silica gel and the spacer group comprises an aryl-silane linker group.

16. A method for making a solid support derivatized with a dihydroxyalkylamine group comprising mixing an aminoalkylated or aminobenzylated solid support comprising a primary amino group, with an excess of an epoxide, and a solvent, thereby derivatizing the solid support with a dihydroxyalkylamine group comprising a tertiary amine having two hydroxyalkyl substituents or two substituted hydroxyalkyl substituents.

17. The method of claim 16, wherein the dihydroxyalkylamine group has the formula $\text{HO}(\text{CH}_2)_2\text{N}(\text{CH}_2)_2\text{OH}$.

18. The method of claim 16, wherein the dihydroxyalkylamine group has the formula $\text{HO}\text{CR}_2\text{CH}_2\text{NCH}_2\text{CR}_2\text{OH}$, and R is independently selected from the group consisting of H, $\text{C}_1\text{-C}_{20}$ alkyl radical, and $\text{C}_1\text{-C}_{20}$ substituted alkyl radical.

19. The method of claim 16, wherein the mixing takes place under pressurized conditions in a sealed, pressure resistant container.

20. The method of claim 16, wherein the epoxide comprises ethylene oxide, and the dihydroxyalkylamine group comprises a N,N-diethanolamine group.

21. The method of claim 20, wherein the ethylene oxide in the sealed, pressure resistant container is a gas at about 1 to about 20 atmospheres.

22. The method of claim 20, wherein the reaction takes place at about 50°C .

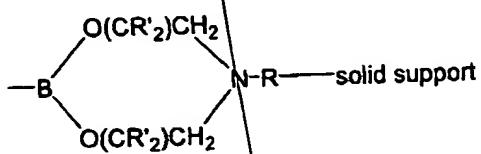
23. The method of claim 16, wherein the epoxide comprises isobutylene oxide and the dihydroxyalkylamine group comprises a diisobutanolamine group.

24. The method of claim 16, wherein the epoxide comprises an aryl-substituted oxirane.

25. The method of claim 16, wherein the solvent comprises a tetrahydrofuran/water mixture or dioxane.

26. The method of claim 16, wherein the mixing lasts for about 12 to 72 hours.

27. A boronic ester-dioxyalkylaminoalkyl- or boronic ester-dioxyalkylaminobenzyl-conjugated solid support, wherein the boronic ester-dioxyalkylamino group has a formula



wherein R comprises an alkyl or a benzyl group, and R' is selected from the group consisting of H, C₁-C₂₀ alkyl radical, and C₁-C₂₀ substituted alkyl radical.

28. The boronic ester-dioxyalkylaminoalkyl- or boronic ester-dioxyalkylaminobenzyl-conjugated solid support of claim 27, wherein the boronic ester is an aryl boronic ester, a vinylboronic ester or an alkylboronic ester.

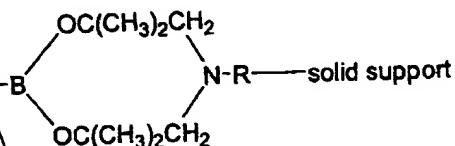
29. The boronic ester-dioxyalkylaminoalkyl- or boronic ester-dioxyalkylaminobenzyl-conjugated solid support of claim 27, wherein the solid support is selected from the group consisting of:

- i. a polystyrene or an equivalent composition;
- ii. a plastic or a plastic co-polymer;
- iii. a silica or a silica gel;
- iv. cellulose or cellulose acetate;
- v. a polyphenol, a polyvinyl, a polypropylene, a polyester, a polyethylene, a polyethylene glycol, a polystyrene-copolymer, or a co-polymeric mixture thereof;
- vi. a poly(vinyl alcohol) (PVA) hydrogel;
- vii. a polyacrylamide.

30. The boronic ester-dioxyalkylaminoalkyl- or boronic ester-dioxyalkylaminobenzyl-conjugated solid support of claim 29, wherein the polystyrene is a cross-linked poly(styrene-divinylbenzene) (PS-DVB) copolymer.

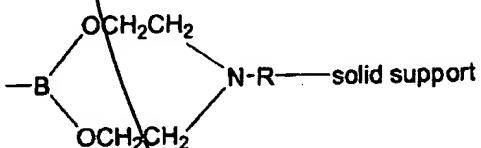
31. The boronic ester-dioxyalkylaminoalkyl- or boronic ester-dioxyalkylaminobenzyl-conjugated solid support of claim 30, wherein the cross-linked poly(styrene-divinylbenzene) (PS-DVB) copolymer is about 1% to 2% cross-linked.

32. The boronic ester-dioxyalkylaminoalkyl or boronic ester-dioxyalkylaminobenzyl-conjugated solid support of claim 27, wherein the boronic ester-dioxyalkylamino group has the formula



wherein R comprises an alkyl or a benzyl group.

33. The boronic ester-dioxyalkylaminoalkyl- or boronic ester-dioxyalkylaminobenzyl-conjugated solid support of claim 27, wherein the boronic ester-dioxyalkylamino group has the formula

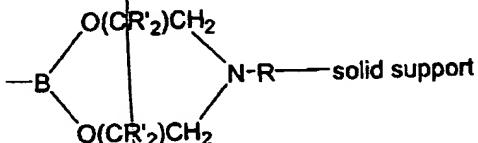


wherein R comprises an alkyl or a benzyl group.

34. A method for making a boronic ester-dioxyalkylaminoalkyl- or boronic ester-dioxyalkylaminobenzyl-conjugated solid support comprising the following steps:

- mixing an aminoalkylated or aminobenzylated solid support comprising a primary amino group, with an excess of an epoxide, and a solvent, thereby derivatizing the solid support with a dihydroxylalkylamine group comprising a tertiary amine having two hydroxyalkyl or two substituted hydroxyalkyl substituents;

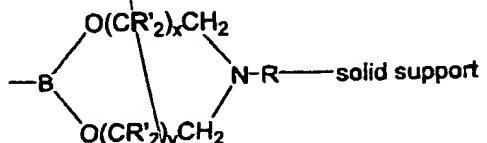
(b) mixing the dihydroxyalkylamine-derivatized solid support of step (a) with a boronic acid, in an anhydrous solvent, thereby derivatizing the solid support with a boronic ester-dioxyalkylaminoalkyl or dioxyalkylaminobenzyl group having the formula



wherein R comprises an alkyl or a benzyl group, and R' is selected from the group consisting of H, C₁-C₂₀ alkyl radical, and C₁-C₂₀ substituted alkyl radical.

35. A method for immobilizing a boronic acid comprising the following steps:

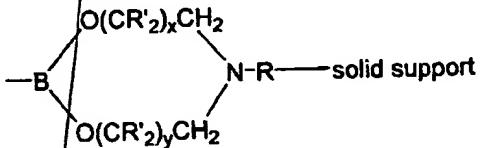
- providing a solid support derivatized with a dihydroxyalkylaminoalkyl group or a dihydroxyaminobenzyl group, wherein the dihydroxyalkylamino moiety has a formula HO (CR'₂)_x CH₂N CH₂(CR'₂)_y OH, wherein R' is independently selected from the group consisting of H, C₁-C₂₀ alkyl radical, and C₁-C₂₀ substituted alkyl radical, and x and y are integers between 1 to about 20,
- providing a sample comprising at least one boronic acid; and
- mixing the solid support of step (a) with the sample of step (b) in an anhydrous solvent, thereby immobilizing a boronic acid by generating a boronic ester-dioxyalkylaminoalkyl- or dioxyalkylaminobenzyl-conjugated group having the formula



wherein R comprises an alkyl or a benzyl, R' comprises at least one of H and C₁-C₂₀ radical, and x and y are integers between 1 to about 20.

36. A method for purifying a boronic acid comprising the following steps:

- (a) providing a solid support derivatized with a dihydroxyalkylaminoalkyl group or a dihydroxyaminobenzyl group, wherein the dihydroxyalkylamino moiety has a formula HO (CR'₂)_x CH₂N CH₂(CR'₂)_y OH, wherein R' is independently selected from the group consisting of H, C₁-C₂₀ alkyl radical, and C₁-C₂₀ substituted alkyl radical, and x and y are integers between 1 to about 20,
- (b) providing a sample comprising at least one boronic acid;
- (c) mixing the solid support of step (a) with the sample of step (b) in an anhydrous solvent, thereby immobilizing a boronic acid by generating a boronic ester-dioxyalkylaminoalkyl- or dioxyalkylaminobenzyl-conjugated group having the formula



wherein R comprises an alkyl or a benzyl, R' comprises at least one of H and C₁-C₂₀ radical, and x and y are integers between 1 to about 20; and

- (d) hydrolyzing the boronic ester linkage, thereby releasing from the support a purified boronic acid.

37. The method of claim 36, wherein the hydrolyzing of step (d) is in a solution comprising tetrahydrofuran, water and acetic acid.

38. The method of claim 36, wherein the hydrolyzing of step (d) is in a solution comprising tetrahydrofuran and water.

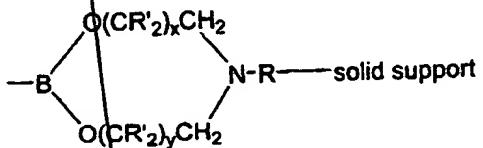
39. The method of claim 36, further comprising washing the solid support at least once with an anhydrous solvent after the mixing of step (c) and before the hydrolysis of step (d).

40. The method of claim 36, performed in a batch or a column.

41. The method of claim 36, performed in an automated or semiautomated synthesizer.

42. A method for scavenging a boronic acid from a multiple component solution to generate a boronic acid-free solution comprising the following steps:

- providing a solid support derivatized with a dihydroxyalkylaminoalkyl group or a dihydroxyaminobenzyl group, wherein the dihydroxyalkylamino moiety has a formula $\text{HO}(\text{CR}'_2)_x\text{CH}_2\text{N}$ $\text{CH}_2(\text{CR}'_2)_y\text{OH}$, wherein R' is independently selected from the group consisting of H , $\text{C}_1\text{-C}_{20}$ alkyl radical, and $\text{C}_1\text{-C}_{20}$ substituted alkyl radical, and x and y are integers between 1 to about 20,
- providing a sample comprising at least one boronic acid;
- mixing the solid support of step (a) with the sample of step (b), thereby immobilizing a boronic acid by generating a boronic ester-dioxyalkylaminoalkyl- or dioxyalkylaminobenzyl-conjugated group having the formula



wherein R comprises an alkyl or a benzyl, R' comprises at least one of H and C₁-C₂₀ radical, and x and y are integers between 1 to about 20; and

(d) washing the solid support after the mixing of step (c) to remove non-boronic acid components; thereby scavenging the boronic acid from the multiple component sample to generate a boronic acid-free solution.

43. The method of claim 42, wherein a molar excess of the support versus an estimated amount of boronic acid in the multiple component sample is used.

44. A method for the solid phase synthesis of functionalized compounds comprising the following steps:

(a) providing a boronic ester-dioxyalkylaminoalkyl or -dioxyalkylaminobenzyl-conjugated solid support,

(b) providing a vinyl halide- or aryl halide- conjugated solid support;

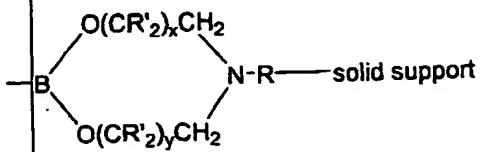
(c) providing a transfer agent;

(d) combining the conjugated support of step (a) with the conjugated support of step (b) and the transfer agent of step (c) under conditions comprising a catalyst, a base and a solvent, thereby effecting coupling of the aryl or vinyl group of the conjugated support of step (a) with the vinyl or aryl group of step

(e) to produce a solid supported, functionalized reaction product;

(f) liberating the functionalized compound from the solid support.

45. The method of claim 44, wherein the boronic ester-dioxyalkylaminoalkyl or -dioxyalkylaminobenzyl-conjugated solid support comprises the formula



wherein R comprises an alkyl or a benzyl, R' comprises at least one of H and C₁-C₂₀ radical, and x and y are integers between 1 to about 20; and

46. The method of claim 44, wherein the functionalized compound of step (e) is liberated from the solid support by reacting the solid supported reaction product of step (d) with a solvent comprising an acid and a non-protic, non-polar solvent.

47. The method of claim 44, wherein the synthesized functionalized compound liberated from the solid support in step (e) comprises a functionalized biphenyl compound.

48. The method of claim 44, wherein the solid-supported boronic ester derivative originates from a poly-functionalized arylboronic acid containing at least one of the following substituents at at least one of the ortho-, meta- and para- positions:

- (a) a carboxamide;
- (b) a carboxylic ester;
- (c) a methylamino group;
- (d) an anilide group comprising an acyl group;
- (e) a urea comprising an acylamino group;
- (f) a sulfonamide comprising a sulfonyl group; or
- (g) an aryl alkyl ether.

49. The method of claim 44, wherein the molar equivalent ratio of solid supported boronic ester of step (a) to the conjugated solid support of step (b) is about 3 to about 4.

50. The method of claim 44, wherein the solid support comprises a polystyrene resin.

51. The method of claim 44, wherein the solid-supported aryl halide of step (b) is a solid-supported polysubstituted halobenzoic acid, a solid-supported amino-substituted haloarene or a solid-supported aminoalkyl-substituted haloarene.

52. The method of claim 44, wherein the catalyst of step (d) comprises a Pd(0) catalyst or a Pd(II) pre-catalyst.

53. The method of claim 44, wherein the Pd(0) catalyst comprises a $\text{Pd}(\text{PPh}_3)_4$ or a $\text{Pd}_2(\text{dba})_3$.

54. The method of claim 44, wherein the solvent of step (d) comprises an aqueous solvent.

55. The method of claim 44, wherein the transfer agent of step (c) comprises an aqueous solvent.

56. The method of claim 44, wherein the base of step (d) comprises sodium carbonate, a trialkylamine, potassium fluoride, sodium fluoride or cesium fluoride.

57. The method of claim 44, wherein the reaction conditions of step (d) comprise a temperature of between about 25°C to about 120°C.

58. The method of claim 44, wherein the reaction conditions of step (c) comprise a reaction time of between about 1 hours to about 72 hours.

59. The method of claim 44, wherein the solvent of step (d) comprises an anhydrous basic solvent.

60. The method of claim 59, wherein the solvent of step (d) further comprises ethylene glycol as a co-solvent.

61. The method of claim 59, wherein the solvent of step (d) comprises at least one tertiary amine base.

62. The method of claim 59, wherein the reaction conditions of step (d) comprise a temperature of between about 25°C to about 120°C.

63. The method of claim 44, wherein the reaction takes place in semiautomated parallel synthesizer.

64. A semiautomated parallel synthesizer comprising
(a) a boronic ester-dioxyalkylaminoalkyl or -dioxyalkylaminobenzyl-conjugated solid support, and
(b) a vinyl halide- or aryl halide-conjugated solid support.

65. A method for the solid phase synthesis of functionalized compounds comprising the following steps:
(a) providing a first reactant comprising a boronic ester-dioxyalkylaminoalkyl- or -dioxyalkylaminobenzyl- conjugated solid support,
(b) providing a second reactant conjugated to a solid support;
(c) providing a transfer agent;
(d) providing a solvent
(e) reacting the boronic ester-dioxyalkylaminoalkyl- or -dioxyalkylaminobenzyl- conjugated solid support of step (a) with the second reactant of step (b) and the transfer agent of step (c) in the solvent of step (d), thereby producing a solid supported, functionalized reaction product;
(f) liberating the functionalized compound from the solid support.

66. The method of claim 65, wherein the solvent of step (d) comprises an anhydrous solvent.

67. The method of claim 65, wherein the solvent of step (d) comprises an aqueous solvent.

68. The method of claim 67, wherein the transfer agent of step (c) comprises the solvent of step (d).

69. The method of step 67, wherein the transfer agent of step (c) comprises water.

70. The method of step 67, wherein the transfer agent of step (c) comprises an alcohol.

71. A method for the solid phase synthesis of functionalized glycine compounds comprising the following steps:

- (a) providing a boronic ester-dioxyalkylaminoalkyl- or dioxyalkylaminobenzyl conjugated solid support,
- (b) providing a solid-supported iminium compound;
- (c) providing a transfer agent;
- (d) reacting the boronic ester-dioxyalkylaminoalkyl- or dioxyalkylaminobenzyl conjugated solid support of step (a) with the transfer agent of step (c) and the solid-supported iminium of step (b) in a solvent, thereby producing a solid supported, functionalized glycine reaction product; and,
- (e) liberating the functionalized compound from the solid support.

72. The method of claim 71, wherein the solvent of step (d) comprises a hydroxylic solvent.

73. The method of claim 71, wherein the hydroxylic solvent acts as the transfer agent of step (c).

74. The method of claim 71, wherein reacting step (e) lasts for about 12 hours to about 48 hours.

75. The method of claim 71, wherein the functionalized compound of step (e) is liberated from the solid support by reacting the solid supported reaction product of step (d) with a solvent comprising an acid and a non-protic, non-polar solvent.

76. The method of claim 71, wherein step (d) further comprises the step of washing the solid supported, functionalized reaction product at least once with a solvent prior to liberating of the compound of step (e).

77. A method for the solid-phase derivatization of a functionalized boronic acid comprising the following steps:

- (a) providing a dihydroxyalkylaminoalkyl or dihydroxyalkylaminobenzyl-conjugated solid support;
- (b) providing a sample comprising a functionalized boronic acid;
- (c) mixing the solid support with the sample in an anhydrous solvent, thereby immobilizing the functionalized boronic acid by generating a functionalized boronic ester-dioxyalkylaminoalkyl- or boronic dioxyalkylaminobenzyl-conjugated group;
- (d) providing at least one derivatizing agent capable of reacting with the functional group of the functionalized boronic acid; and
- (e) contacting the derivatizing agent of step (d) with the functionalized boronic ester-dioxyalkylaminoalkyl- or functionalized boronic ester dioxyalkylaminobenzyl-conjugated group in a solvent, thereby producing a solid supported, derivatized boronic acid product.

R.126 78-79. The method of claim 77, further comprising reacting the solid supported, derivatized boronic acid with a solvent, thereby liberating the derivatized boronic acid from the solid support.

R.124980. The method of claim 77, wherein the functionalized boronic acid of step (b) comprises a formyl-functionalized benzeneboronic acid, and the derivatizing agent of step (d) comprises a primary or secondary amine, along with sodium borohydride.

80.81. The method of claim 77, wherein the functionalized boronic acid of step (b) comprises a bromomethyl-functionalized benzeneboronic acid, and the derivatizing agent of step (d) comprises a primary or secondary amine.

81.82. The method of claim 77, further comprising a coupling agent, and wherein the functionalized boronic acid of step (b) comprises a carboxy-functionalized arylboronic acid, and the derivatizing agent of step (d) comprises an amine.

82.83. The method of claim 77, wherein the functionalized boronic acid of step (b) comprises an amino-functionalized boronic acid, and the derivatizing agent of step (d) comprises a isocyanate.

83.84. The method of claim 78, wherein step (e) further comprises the step of washing the solid supported, derivatized reaction product at least once with a solvent prior to liberating of the compound.